Do native Australian small mammals avoid faeces of domestic dogs? Responses of *Rattus fuscipes* and *Antechinus stuartii*

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ABSTRACT

Domestic dogs are typically prohibited from National Parks and other wildlife reserves partly because managers fear that dog faeces will deter native small mammals from their normal behaviours. We tested this notion for two native small mammals in Ku-ring-gai Chase National Park, near Sydney Australia by comparing the first-night trap success of traps with experimental addition of domestic dog faeces placed near the trap entrance to control traps. Bush Rats *Rattus fuscipes*, the most abundant species captured, showed no aversion to dog faecal odours across 20 sampled sites and entered control and dog-scented traps equally (n=73 captures). Also, the presence of dog faeces had no association with the body size or sex of captured animals. This lack of response may be because rats do not identify dog scats as a cue to predation risk or because dog scats are an unreliable cue to predation hazards. Either way, faeces from domestic dogs dropped in native habitats appear unlikely to deter small native fauna due to predator avoidance behaviours. Further research is needed to resolve other impacts of dog scats, such as disease transfer to native mammal populations.

Key words: Australia, field experiment, odour avoidance, predator-prey; predator scat, chemical signal exploitation

Introduction

The risk of predation can strongly alter the behaviour and activity of potential prey (Lima and Dill 1990). In assessing predation hazards, many species use remote cues of risk because of the dangers of direct encounters with predators, including avoidance of open areas (e.g. Banks *et al.* 1999) or changing the time that they forage. Predator odours such as those found in faeces (scats, droppings) may also provide reliable cues to predation risk and their role in prey deterrence has been extensively researched (Kats and Dill 1998). Individual predators use scats to communicate information about their sex and status (e.g. dogs, Corbett 1995) which then attracts passing conspecifics, frequently stimulating over marking. As a result, areas with predator scats may be more likely to be visited by other predators and potential prey are thought to reduce their risks of predator encounter by avoiding these areas (scat-avoidance hypothesis). Co-evolution of such chemical signal exploitation is thought to be widespread (Zuk and Kollaru 2000); avoidance behaviours are species specific for some predator-prey systems (Jedrzejewski *et al.* 1993), whereas other potential prey show generalised avoidance of carnivore scats without requisite exposure in either evolutionary time or short term experience (e.g. Dickman 1992).

In light of this extensive empirical research, largely from laboratory studies of rodents and their predators in Europe and North America, many wildlife management agencies in Australia consider that the faeces of Domestic Dogs *Canis lupus familiaris* may alter the behaviour of local native small mammals. Domestic dogs are typically banned from National Parks in part because their scats are thought to disturb native fauna from their normal areas of activity, and visitors are prohibited from walking their dogs on National Park tenure (NSW NPWS 1999). Although there is little information available about whether Australian native small mammals respond to any predator odours (but see Banks 1998), the presumed deterrent effect of dog faeces on native fauna has become a management dogma. Domestic dogs are closely related to the Dingo *Canis lupus dingo*, which arrived in Australia ca. 6000 years ago (Corbett 1995) and share an evolutionary history with Australian native small mammals under which scat-avoidance behaviours may have evolved. But small mammals typically form only a very minor part of wild dogs' diet (Fleming *et al.* 2001), suggesting that predation, which may drive selective pressure on the evolution of avoidance, has been low. Moreover, many environments may be saturated with faecal remains of a range of potential predators, including other canids like wild dogs and Foxes *Vulpes vulpes*, such that their use as a refined cue to variable predation hazard is diminished (Powell and Banks in press).

In this paper we use an experimental live trapping study to investigate whether small mammals avoid areas with domestic dog faeces in order to test the basis of the scat-avoidance hypothesis in NSW National Parks policy. We target the most common small mammal species in the forests of south-eastern Australia; the Bush Rat *Rattus fuscipes,* as an example of a placental mammal, and the Brown Antechinus *Antechinus stuartii,* as an example of a marsupial. If dog faeces do induce an avoidance response in these species, we predict that there should be fewer captures in traps closely associated with dog faeces.

Methods

Study area

The study was conducted in Ku-ring-gai Chase National Park, one of the most popular National Parks in NSW, located approximately 20 km north of the centre of Sydney and with extensive residential areas to the east and south. Vegetation in the park includes wet and dry heath, low eucalypt woodland and open forest. Small, ground dwelling mammal fauna of the park include Bush Rats and Brown Antechinus, and less commonly, New Holland Mouse *Pseudomys novaehollandiae*, Southern Brown Bandicoot *Isoodon obesulus* and Long-nosed Bandicoot *Perameles nasuta.* Introduced predators recorded within the park include the domestic dog (including roaming pets and feral individuals), Red Fox and Cat *Felis catus.*

Experimental design

Twenty independent small mammal trapping transects (>400m apart) were established during February 2003 in areas of eucalypt woodland with a heathy understorey immediately adjacent to walking tracks, fire trails and creek lines where dogs might be walked. Each transect consisted of 16 Type A Elliott traps (30 x 10 x 10 cm) placed 12m ± 2m apart in suitable small mammal microhabitats. Fresh domestic dog faeces (collected from kennel animals fed on commercial pet foods) were placed at the entrance to every second trap.

Traps were baited with a rolled oats/peanut butter mix and provided with non-absorbent cotton wool bedding. Traps were set for one night only in each location in order to investigate the immediate response of small mammals to dog odour (see also Banks 1998) and to avoid problems of habituation masking avoidance. Clean (no dog faeces) and scented (with dog faeces) traps were always handled and set by different people to prevent contamination of clean traps. For each captured animals, sex, weight (to nearest 1g) and reproductive condition were noted.

Data analysis

Because treatments were applied to alternate traps within individual transects, both treatment and transect may influence trap success. To solve this problem with a simple analysis, small mammal responses to dog faeces were considered at the level of the transect, rather than the individual trap point. Thus within a transect, clean traps that successfully captured an animal were given a score of +1, while successful dog-scented traps were given a score of –1 (sensu Banks 1998). Scores were added to give a total for each transect. If animals strongly avoided dog-scented traps, it was expected that the mean score for each transect would be positive. Thus, the mean score accross transect was tested against a null hypothesis that there was no avoidance of dog-scented traps using a one-sample Student's *t*-test with transects as replicates. All tests were two-tailed and significance set at $P<0.05$.

Results

A total of 87 individual animals were caught from 320 trap nights (27% trap success), consisting of 73 Bush Rats, 9 *A. stuartii* and 5 lizards. For Bush Rats, there were 38 captures in clean traps and 35 captures in dog-scented traps. Mean preference score (±1SE) across all sites was 0.50±.0.37, which was not different from 0 ($t_{18}=1.34$, d.f.=18, $P=0.20$), indicating no preference or avoidance of dog odours (Figure 1). Similarly, odour preference scores for transects did not differ between captures of male and female (two sample test $t_{30}= 0.27$, $P=0.79$) nor juvenile and adult (two sample $t_{24}=0.16$, $P=0.87$) (Figure 2). In addition, there was no association between adult male and female body size and capture rates in unscented and dog-scented traps (males $t_{30}=2.01$, $P=0.63$; females $t_{21}=2.10$, $p=0.20$). In contrast, significantly more *A. stuartii* were captured in control traps (9:0 Sign test $P<0.02$)

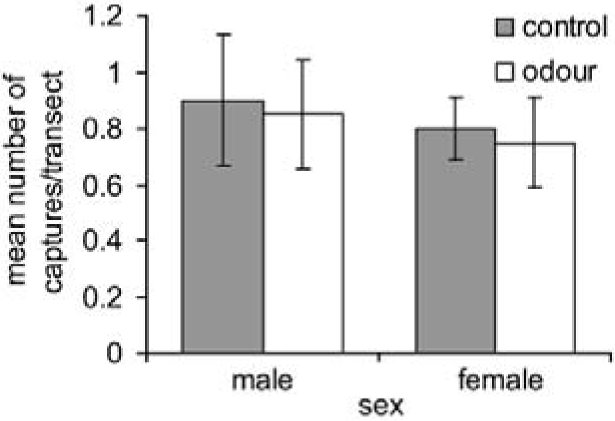

Figure 1: Mean number of captures (±1SE) of male and female *Rattus fuscipes* per transect in control traps and those with dog scats (odour).

Discussion

Contrary to predictions of the scat-avoidance hypothesis, Bush Rats in this study showed no response to dog faeces, with equal captures in control and dog scented traps. This generalised lack of response was consistent across the sexes and across body sizes. Traps were baited with peanut butter and oats to attract small mammals, but the presence of dog faeces did not affect this attraction. Thus it is unlikely that dog faeces dramatically affects the foraging and movement behaviour of Bush Rats under field conditions. Post-hoc power analysis showed that our design was powerful enough to detect avoidance scores of >1.1 (for $\alpha= 0.05$, $\beta=0.2$) where mean capture rate was 3.7 animals per transect. But given the overall similarity in capture rates in control and scented traps, more subtle avoidance not detected by our design seems very unlikely.

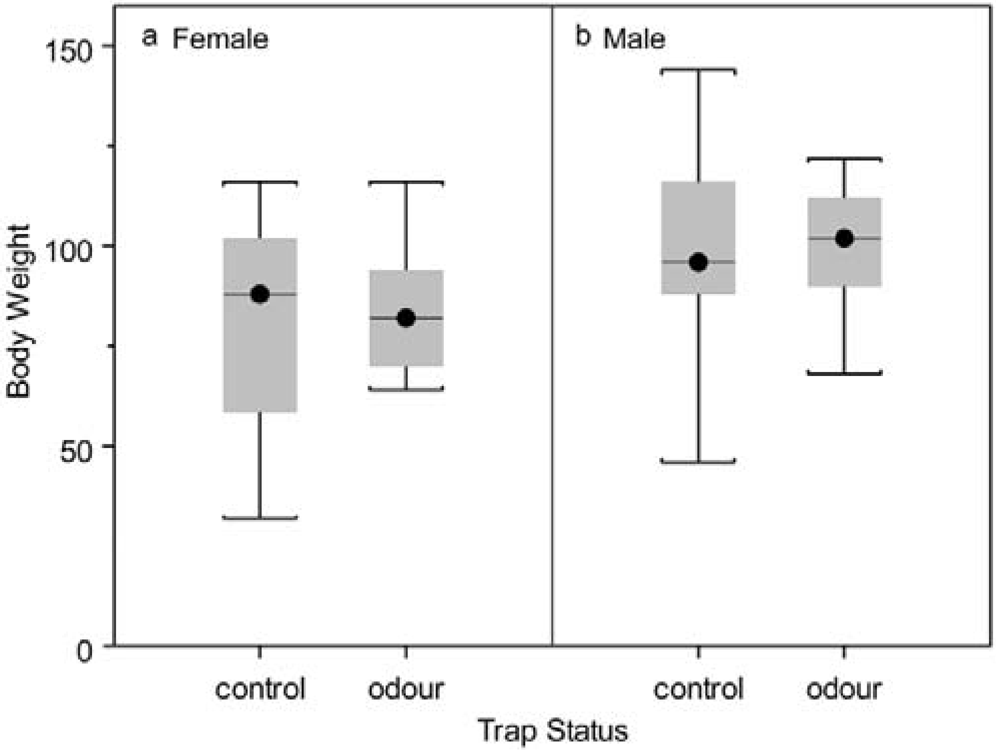

Figure 2: Box plots of body weight (g) of (a) female (control n = 17; odour n = 14) and (b) male (control n = 19; odour n = 16) *Rattus fuscipes* captured in control traps and those with dog odour. Plots show median (line with dot), upper and lower quartiles (box limits) and upper and lower limits of data.

So why didn't Bush Rats respond to dog odours given a strong theoretical premise for avoidance? Banks (1998) proposed that Bush Rats didn't respond to fox scats because foxes are a novel predator in evolutionary time (only ca. 150 years). Yet dingoes have been in Australia more than 6000 years and would have been local predators of rats at Ku-ring-gai Chase. Roaming dogs continue to be problem in our study area (NSW NPWS 1999), so dog odours would not have been novel to local rodent populations. The "scat-at trap" technique that we used is likely to have been appropriate, as it has detected avoidance responses by potential prey in other systems (e.g. Dickman and Doncaster 1984; Dickman 1992). Because we only measured first night responses of rodents, we avoided problems of habituation masking avoidance (Williams *et al.* 1990). However, neophobic individuals may have been missed, although it is not clear whether dog odours would induce stronger neophobic aversion than clean traps alone. Also we used scats (that also contained some urine), from domestic dogs fed on commercial pet food. Whereas scats of predators fed on vegetarian diets do not elicit responses of their prey, subtle changes in predator diets do not necessarily change the deterrence qualities of scats (Nolte *et al.* 1994; Berton *et al.* 1998). More generally, the effects of dog faeces on the behaviour of other potential prey of dogs are poorly known.

We do not know the risks posed to rodents by wild dogs in our study areas, but elsewhere Bush Rats likely form a supplemental or opportunistic source of food (sensu Newsome *et al.*. 1983) for dogs in comparable habitat (e.g. 4% of scats B. Mitchell unpublished in montane forest; 2.5-3% reported for coastal woodland and heath in Newsome *et al.*. 1983, see also Meek and Triggs 1998). Thus it is likely that dogs pose only a minor threat to individual rodents and exert only low selective pressure on the evolution of predator scat avoidance. In contrast, Least Weasels *Mustela nivalis nivalis* kill 47% of adult Field Voles *Microtus agrestis* every three weeks (Banks *et al.* 2000), and field voles show strong avoidance of weasel odours (Stoddart 1976; Jedrzejewski *et al.* 1993).

But are dog faeces a reliable cue to real predation risk for potential prey? Faeces are a ubiquitous and unavoidable result of digestive processes as well as deliberate chemical signals to conspecifics, and canid scats can persist for > 2 months in the field (P. Banks unpublished). Wild dogs typically have large home ranges (2-50km^2 in forest habitats, Corbett 1995) and individuals may not cover their whole range in a night to inspect new odour sites, such that regular predator visitation rates to sites with faeces is likely to be low. We had 160 trap locations with dog scats but recorded no signs of trap disturbance by predators, which otherwise can signal predator activity in an area (Banks 1999; Tasker and Dickman 2001). Furthermore, in wolf populations, scats may actually reduce activity of conspecifics in areas with social conflict such as territory boundaries (Lewis and Murray 1993). Although little is known about odour-mediated predator-prey contact rates, predator encounter at a scat location is likely to be fairly low, especially where densities of predators are low relative to densities of prey. Thus we suggest that dog faeces do not accurately indicate immediate risks of predator encounter and risk of being killed. Some potential prey may still overestimate their risks of predation (Abrams 1994), but generally faecal remains are likely to be a diffuse cue to predation hazard that is frequently ignored by foraging animals with immediate breeding and survival requirements (Jones and Dayan 2000; Jonsson *et al.* 2000); issues that are less pressing for well maintained laboratory animals upon which much predator odour research has been conducted.

Antechinus captures were fewer than for Bush Rats but showed a 9:0 avoidance of dog-scented traps. Despite this apparent avoidance, the small sample size meant that just one additional capture in a dog scented trap (assuming a random event P=0.5) would give a non-significant sign test result. Banks (1998) reported no avoidance of fox scats for *A. stuartii* (now *A. agilis*) (n=25 captures) and Dickman (1993) reported no response to cat odours by closely related *A. flavipes*. Thus further work into the responses of dasyurid marsupials to dog odours is needed to resolve this issue.

Our results suggest that banning domestic dogs in National Parks and bushland areas because dog faeces might substantially disrupt the natural behaviours of small mammals is unjustified, at least for Bush Rats. It is possible that other mammals vulnerable to dog predation may avoid dog odours (e.g. macropods Montague *et al.* 1990 or possums Woolhouse and Morgan 1995), but the general reliability of scats as a cue to assess predation hazard remains an issue for these potential prey too. Uncontrolled domestic dogs can nevertheless chase and kill small native mammals, and their faeces may expose unperturbed wildlife to scat-borne parasites, such as hydatids and nematode worms (Fleming *et al.* 2001) to warrant dog prohibition in protected areas. However, it seems unlikely that domestic dog faeces will induce major changes in foraging or movement behaviour to the long-term detriment of some native small mammal fauna.

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References

Abrams, P.A. 1994. Should prey overestimate the risk of predation? *American Naturalist* **144**: 317-328.

Banks, P.B. 1998. Responses of Australian bush rats, *Rattus fuscipes*, to the odor of introduced *Vulpes vulpes*. *Journal of Mammalogy* **79**: 1260-1264.

Banks, P.B. 1999. Predation by introduced foxes on native bush rats in Australia: do foxes take the doomed surplus? *Journal of Applied Ecology* **36**: 1063-1071.

Banks, P.B., Hume, I.D., and Crowe, O. 1999. Behavioural, morphological and dietary response of rabbits to predation risk from foxes. *Oikos* **85**: 247-256.

Banks, P.B., Norrdahl, K. and Korpimäki, E. 2000. Nonlinearity in the predation risk of prey mobility. *Proceedings of the Royal Society of London B* **267**: 1621-1625.

Berton, F., Vogel, E. and Belzung, C. 1998. Modulation of mice anxiety in response to cat odor as a consequence of predators diet. *Physiology and Behavior* **65:** 247-254.

Corbett, L.K. 1995. *The Dingo in Australia and Asia*. Kensington: UNSW Press.

Dickman, C.R. and Doncaster, C.P. 1984. Responses of small mammals to Red fox (*Vulpes vulpes*) odour. *Journal of Zoology, London* **204**: 521-531.

Dickman, C.R. 1992. Predation and habitat shift in the House mouse, *Mus domesticus*. *Ecology* **73**: 313-322.

Dickman, C.R. 1993. Raiders of the last ark: cats in island Australia. *Australian Natural History* **24**: 44-52.

Fleming, P., Corbett, L.K., Harden, R.D., and Thompson, P. 2001. *Managing the Impacts of Dingoes and other Wild Dogs*. Canberra: Bureau of Resource Sciences.

Jedrzejewski, W., Rychlik, L. and Jedrzejewska, B. 1993. Responses of bank voles to odours of seven species of predators: Experimental data and their relevance to natural predator-vole relationships. *Oikos* **68**: 251-257.

Jones, M. and Dayan, T. 2000. Foraging behavior and microhabitat use by Spiny mice, *Acomys cahirinus* and *A. russatus*, in the presence of Blandford's fox (*Vulpes cana*) odor. *Journal of Chemical Ecology* **26:** 455-469.

Jonsson, P., Koskela, E., and Mappes, T. 2000. Does risk of predation by mammalian predators affect the spacing behaviour of rodents? Two large-scale experiments. *Oecologia* **122**: 487-492.

Kats, L.B. and Dill, L.M. 1998. The scent of death: chemosensory assessment of predation risk by prey animals. *Ecoscience* **5**: 361-394.

Lewis, M.A. and Murray, J.D., 1993. Modelling territoriality and wolf-deer interactions. *Nature* **366**: 738-740.

Lima, S.L. and Dill, L.M., 1990. Behavioral decisions made under the risk of predation: a review and prospectus. *Canadian Journal of Zoology* **68**: 619-640.

Meek, P.D. and Triggs, B. 1998. The food of foxes, dogs and cats on two peninsulas in Jervis Bay, NSW. *Proceedings of the Linnean Society NSW* **120:** 117-127.

Montague, T.L., Pollock, D.C. and Wright, W. 1990. An examination of the browsing animal problem in Australian eucalypt and pine plantations. *Proceedings of the 14th Vertebrate Pest Conference* **14**: 203-208.

Newsome, A.E., Catling, P.C. and Corbett, L.K. 1983. The feeding ecology of the dingo (*Canis familiaris dingo*): 2. Dietary and numerical relationships with fluctuating prey populations in southeastern Australia. *Australian Journal of Ecology* **8**: 345-366.

Nolte, D.L., Mason, J.R., Epple, G., Aronov, E. and Campbell, D.L. 1994. Why are predator urines aversive to prey? *Journal of Chemical Ecology* **20:** 1505-1516.

NSW NPWS 1999. *Ku-Ring-Gai Chase National Park, Lion Island, Long Island, and Spectacle Island Nature Reserves Draft Plan of Management*. Hurstville: NSW NPWS.

Powell, F. and Banks, P.B., in press**.** Do house mice modify their foraging behaviour in response to predator odours and habitat? *Animal Behaviour*

Stoddart, D.M. 1976. Effect of the odour of weasels (*Mustela nivalis* L.) on trapped samples of their prey. *Oecologia* **22**: 439-441.

Tasker, E.M. and Dickman, C.R. 2002. A review of Elliot trapping methods for small mammals in Australia. *Australian Mammalogy* **23**: 77-87.

Williams, J.L., Rogers, A.G. and Adler, A.P. 1990. Prolonged exposure to conspecific and predator odors reduces fear reactions to these odors during subsequent prod-shock tests. *Animal Learning and Behavior* **18**: 453-461.

Woolhouse, A.D. and Morgan, D.R., 1995. An evaluation of repellents to suppress browsing by possums. *Journal of Chemical Ecology* **21**: 1571-1583.

Zuk, M. and Kolluru, G.R. 1998. Exploitation of sexual signals by predators and parasitoids. *Quarterly Review of Biology* **73**: 415-438.